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Storage Devices are the data storage devices that are used in the computers to store the data. The computer has many types of data storage devices. Some of them can be classified as the removable data Storage Devices and the others as the non-removable data Storage Devices.
The memory is of **two types**; one is the **primary memory** and the other one is the **secondary memory**.

The primary memory is the volatile memory and the secondary memory is the non-volatile memory. The volatile memory is the kind of the memory that is erasable and the non-volatile memory is the one where in the contents cannot be erased. Basically when we talk about the data storage devices it is generally assumed to be the secondary memory.

The secondary memory is used to store the data permanently in the computer. The secondary storage devices are usually as follows: hard disk drives – this is the most common type of storage device that is used in almost all the computer systems. The other ones include the floppy disk drives, the CD ROM, and the DVD ROM. The flash memory, the USB data card etc.

PRIMARY STORAGE

Primary Storage, also referred to as computer memory, is used by the CPU (Central Processing Unit) of a computer to continuously read and execute programming instructions. Also it reads and writes data from/to the file store in the Secondary Storage of the computer. And this is accessible directly by the CPU. Typical examples of Primary Storage types are RAM, ROM, and memory adapters.

SECONDARY STORAGE

Secondary Storage refers to non-volatile data storage which is not directly accessible by the CPU and only accessible via primary storage devices using I/O (Input/Output) channels or device drivers. Typical examples of Secondary Storage are hard disks, floppy disks, optical storage devices (such as CD , DVD drives), magnetic tape data storage devices, RAM drives, and flash memory (such as USB sticks /keys.)

OFF-LINE STORAGE

Off-line storage or disconnected storage is computer data storage on a medium or a device that is not under the control of a processing unit. The medium is recorded, usually in a secondary or tertiary storage device, and then physically removed or disconnected. This type of storage system must be inserted or connected by a human operator before a computer can access the information.

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CHARACTERISTICS OF STORAGE

VOLATILITY OF INFORMATION

Volatile memory requires a constant power to maintain the stored information. They are required to be very fast and they also are the fastest memory technologies of today (not a universal rule). Non-volatile memory will retain the stored information even if there is no supply of electric power. It is suitable for long-term storage of information. Examples of this category are secondary, tertiary, and off-line storage.

ABILITY TO ACCESS NON-CONTIGUOUS INFORMATION

Information from the storage devices can be either seek sequentially or randomly. In a sequential access the information is seek one after the other. In a random access any location in storage can be accessed at any moment in approximately the same amount of time.

ABILITY TO CHANGE INFORMATION

Certain storage devices information to be overwritten at any time. They are often referred to as Mutable storage. Read only storage retains the information stored during the time of manufacture, and write once storage (WORM) allows the information to be written only once at some point of time after the manufacture. These are called immutable storage.

CAPACITY AND PERFORMANCE

Storage capacity: It is the total amount of stored information that a storage device or medium can hold. E.g. 80GB of hard disk. Storage density: It is the compactness of stored information. E.g. 1.2 Gigabytes per square inch). Latency: It is the time taken to access a particular location in storage. Throughput: It is the rate at which information can be read from or written to the storage.
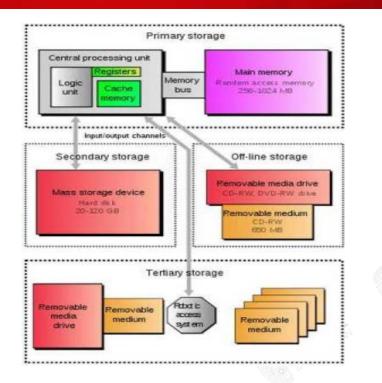
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Different Kinds of Data Storage

Primary Storage
The primary storage is basically the memory in-built in the computer itself such as:

Random Access Memory (RAM)
The computer processor uses it as a scratch pad. It stores the information on a temporary basis. RAM is a fickle memory which loses the entire information the moment you switch off your computer. However, what works in its favor is its greater access rate. Access rate is basically time needed to access to a particular memory. Monetarily, random access memory is expensive.

Read Only Memory (ROM)
It stores the information permanently. In this type of memory, data is stored either by the manufacturer or by the user. The main thing about this type of storage is that the data once stored, cannot be changed. Its access rate is less in comparison with the RAM. ROMs are less expensive than RAM.

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Secondary Storage

These storage devices are external to the basic built in of the computer processor and are used to build more space for storage. The secondary storage cannot be changed, but the information sustains even if the computer is turned off.

Some of the secondary storage devices are:

Hard Drives

Hard drives are present inside the CPU. They store the information in a digital form on the platters having magnetic surface. The information is unchangeable. There are different types of hard drives present today.

Solid State Drives (SSD)

The traditional spinning hard drive (HDD) is the basic nonvolatile storage on a computer. That is, it doesn't "go away" like the data on the system memory when you turn the system off. Hard drives are essentially metal platters with a magnetic coating. That coating stores your data, whether that data consists of weather reports from the last century, a high-definition copy of the *Star Wars* trilogy, or your digital music collection. A read/write head on an arm accesses the data while the platters are spinning in a hard drive enclosure.

An SSD does much the same job functionally (saving your data while the system is off, booting your system, etc.) as an HDD, but instead of a magnetic coating on top of platters, the data is stored on interconnected flash memory chips that retain the data even when there's no power present. The chips can either be permanently installed on the system's motherboard (like on some small laptops and ultra-books), on a PCI/PCI e card (in some high-end workstations), or in a box that's sized, shaped, and wired to slot in for a laptop or desktop's hard drive (common on everything else). These flash memory chips differ from the flash memory in USB thumb drives in the type and speed of the memory. That's the subject of a totally separate technical treatise, but suffice it to say that the flash memory in SSDs is faster and more reliable than the flash memory in USB thumb drives. SSDs are consequently more expensive than USB thumb drives for the same capacities.

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OFFLINE STORAGE DEVICES:

Blu-ray Discs
Gaming lovers generally go for this secondary storage, as they offer high definition video storage. They are the optical storage devices. Physically, blu-ray discs are same as CDs and DVDs. The storage capacity of the blu-ray discs is much larger.

Compact Discs (CD)
CDs are very popular for saving audio, video or any other data. They have the ability to store the information for a longer time. The information is optically stored and is non- fickle. CDs are also known as the offline storage data device, especially used to increase the security of the information. They are hugely used as a backup for important information.

Digital Versatile Disc (DVD)
It stores the data in a similar way as a CD does, but the storage space herein is larger than a CD. Like CDs, these are also known as offline storage data.

Flash Memory
Flash memory is an advanced version of ROMs. The main difference between the two is that in flash cards, the information stored can be electrically erased. The entire erasing process takes place only in few seconds. Also, according to your requirements, you can very easily modify the information.

USB Flash Drives
They are also called as thumb drives. If you want to store the information in a compact and portable way, then USB flash cards are for you. With the help of a USB port, USB flash drives get connected to the computer. They use the universal serial bus interface to save a large amount of information. They can be rewritten and come with a built-in flash memory. USB flash drives can store data of up to 64 gigabytes.

External Hard Drives
They work similarly as hard drives present inside the computer, but the main difference is that they are present outside. They are connected to a computer through a USB port. They can store data of up to 700 gigabytes.

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TYPES OF STORAGE DEVICES

MAGNETIC:

The most common and enduring form of removable-storage technology is **magnetic** storage. For example, 1.44-MB floppy-disk drives using 3.5-inch diskettes have been around for about 15 years, and they are still found on almost every computer sold today. In most cases, removable magnetic storage uses a **drive**, which is a mechanical device that connects to the computer. You insert the **media**, which is the part that actually stores the information, into the drive.

Just like a [hard drive](), the media used in removable magnetic-storage devices is coated with **iron oxide**. This oxide is a **ferromagnetic** material, meaning that if you expose it to a magnetic field it is permanently magnetized. The media is typically called a **disk** or a **cartridge**. The drive uses a motor to rotate the media at a high speed, and it accesses (reads) the stored information using small devices called **heads**.

Each head has a tiny **electromagnet**, which consists of an iron core wrapped with wire. The electromagnet applies a **magnetic flux** to the oxide on the media, and the oxide permanently "remembers" the flux it sees. During writing, the data signal is sent through the coil of wire to create a magnetic field in the core. At the gap, the magnetic flux forms a fringe pattern. This pattern bridges the gap, and the flux magnetizes the oxide on the media. When the data is read by the drive, the **read head** pulls a varying magnetic field across the gap, creating a varying magnetic field in the core and therefore a signal in the coil. This signal is then sent to the computer as [binary data]().

Before music CDs were introduced in the 1980s, portable music devices used magnetic tape in the form of music **cassettes**. Early computers adapted this technology to store digital information. One of the major weaknesses is that information on a tape can only be accessed in a very sequential fashion. This is fine if you want to listen to a whole music album in sequence, but computer systems typically need to access data in a non-sequential manner. For magnetic tape, this means you may need to fast-forward through a lot of tape to get to a specific piece of data. While magnetic tape is a very cheap way to store data, the very slow access to the data meant that it was primarily used for creating back-ups of data in case older forms of storage failed. Tape backup systems are still in use today, but their importance has greatly declined with the advance of cheap, large capacity hard disk drives.

The floppy disk became widely used as a portable storage medium. The floppy disk uses magnetic storage in the form of a thin disk that is protected by a more rigid plastic casing. Data could be written to a floppy disk on one computer using a floppy disk drive, and you could then physically take it to another computer to be read. In a time before computer networks were widely used for data transfer, floppy disks presented an easy-to-use and fast way to move data between computers. Today's equivalent of the floppy disk is the USB flash drive (which does not use magnetic storage), which is used to physically move relatively small amounts of data between multiple computers. By today's standards, floppy disks had a very small capacity in the order of 1MB. Floppy disks were widely used throughout the 1980s and 1990s, but their use declined with the introduction of external hard disk drives and flash-based storage

devices. While once a standard feature on any computer, modern day computer system no longer feature floppy drives.

OPTICAL STORAGE DEVICES:

Optical storage devices save data as patterns of dots that can be read using light. A laser beam is the usual light source.

The data on the storage medium is read by bouncing the laser beam off the surface of the medium. If the beam hits a dot it is reflected back differently to how it would be if there were no dot. This difference can be detected, so the data can be read.

Dots can be created using the laser beam (for media that is writable such as CD-Rs). The beam is used in a high-power mode to actually mark the surface of the medium, making a dot. This process is known as 'burning' data onto a disc.

The different patterns of dots correspond to the data stored on the disc.

Read-Only Optical Discs

Read-only optical discs have data written onto them when they are manufactured. This data cannot be changed.

CD-ROM

Compact Disc - Read-Only Memory (CD-ROM) discs can hold around800MB of data. The data cannot be altered (non-volatile), so cannot be accidently deleted. CD-ROMs are random-access devices.
CD-ROMs are used to distribute all sorts of data: software (e.g. office applications or games), music, electronic books (e.g. an encyclopedia with sound and video.)

DVD-ROM

Digital Versatile Disc - Read-Only Memory (DVD-ROM) discs can hold around 4.7GB of data (a dual-layer DVD can hold twice that). DVD-ROMs are random-access devices.
DVD-ROMs are used in the same way as CD-ROMs (see above) but, since they can hold more data, they are also used to store high-quality video.

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High Capacity Optical Discs

Blu-Ray
Blu-Ray disks are a recent replacement for DVDs. A Blu-Ray disc can hold25 - 50GB of data (a dual-layer Blu-Ray disc can hold twice that). Blu-Ray discs are random-access devices.
Blu-Ray discs are used in the same way as DVD-ROMs (see above) but, since they can hold more data, they are also used to store very high-quality, high-definition (HD)video.

The 'Blu' part of Blu-Ray refers to the fact that the laser used to read the disc uses blue light instead of red light. Blue light has a shorter wave-length than red light (used with CDs and DVDs).

Using a blue laser allows more data to be placed closer together on a Blu-Ray disc, than on a DVD or CD, so Blu-Ray has a much higher storage capacity than these older discs.

HD DVD
High-density DVD (HD-DVD) discs can hold around 15GB of data (a dual-layer HD-DVD can hold twice that). HD-DVDs are random-access devices.
HD-DVD discs are used in the same way as DVD-ROMs (see above) but, since they can hold more data, they are also used to store very high-quality, high-definition (HD) video.

The HD-DVD format was launched at the same time as Blu-Ray. For about a year they competed to be the 'next DVD'. For various reasons, Blu-Ray won the fight, and the HD-DVD format has been abandoned.

Recordable Optical Discs
Recordable optical discs can have data written onto them ('burnt') by a computer user using a special disc drive (a disc 'burner').

CD-R and DVD-R
CD-Recordable (CD-R) and DVD-recordable (DVD-R) discs can have data burnt onto them, but not erased. You can keep adding data until the disc is full, but you cannot remove any data or re-use a full disc.

CD-RW and DVD-RW
CD-Rewritable (CD-RW) and DVD-Rewritable (DVD-RW) discs, unlike CD-Rs and DVD-Rs, can have data burnt onto them and also erased so that the discs can be re-used.
When CD-Rs and DVD-Rs are burnt, the laser makes permanent marks on the silver-colored metal layer. This is why these discs cannot be erased.

When CD-RWs and DVD-RWs are burnt the laser makes marks on the metal layer, but in a way that can be undone. So these discs can be erased.

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DVD-RAM
DVD-Random Access Memory (DVD-RAM) discs are a type of re-writable DVD. They often come in a floppy-disc style case (to protect the disc).

DVD-RAM discs have a similar capacity to a normal DVD, holding 4.7GB of data. DVD-RAM discs are random-access devices.
DVD-RAM discs are used in many camcorders (video recording cameras).

The discs are much higher quality than normal DVD-RWs and can reliably store data for up to 30 years. This means that they are often used for video and data back-up and archiving.

SOLID STATE STORAGE DEVICES
In contrast to magnetic and optical forms of backing storage, these devices have no moving parts and so are called 'solid state'. Instead, they use a special kind of programmable ROM memory chip on which data is stored. Very different to usual memory, this kind of chip remembers the data even when the power has been turned off.

USB Flash Drives
Universal Serial Bus (USB) is a type of socket or port in computer systems that allow USB type devices to connect to it. One of which is the USB Flash Drive - sometimes called pen drive.

USB Flash drives come in various sizes from 16 MB up to and over 4GB. They are very useful and a simple way of backing up and transporting data. Because of the USB connection they will work on any computer with a USB port and have really replaced floppy discs as a method of moving files from one computer system to another.

Memory Cards
Like USB flash drives, these solid state devices come in various sizes, from 64MB to over 2GB. They connect differently and need a card reader to 'read' their contents.

Commonly, they are used in digital cameras to store photographs and are similar to SIM cards used in phones.

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Solid State Hard Drives:

Solid state drives have several advantages over the magnetic hard drives. The majority of this comes from the fact that the drive does not have any moving parts. While a traditional drive has drive motors to spin up the magnetic platters and the drive heads, all the storage on a solid state drive is handled by flash memory chips.

This provides three distinct advantages:
1. Less Power Usage
2. Faster Data Access
3. Higher Reliability

The power usage is a key role for the use of solid state drives in portable computers. Because there is no power draw for the motors, the drive uses far less energy than the regular hard drive. Now, the industry has taken steps to address this with drives spinning down and the development of hybrid, but both of these still use more power. The solid state drive will consistently draw less power than the traditional and hybrid hard drive.

Faster data access will make a number of people happy. Since the drive does not have to spin up the drive platter or move drive heads, the data can be read from the drive near instantly. Hybrid hard drives do tend to mitigate the speed aspect when it comes to frequently used drives. Similarly, Intel's new Smart Response Technology is a similar method of caching on a small solid state drive to produce similar results.

STORAGE REQUIREMENT OF A FILE

Formula to compute storage needs:

Basic storage capacity requirements can be estimated by simple calculation:

Total storage needed = # of image files x average file size x 1.25

Example: A Collection of 3,000 text images, each averaging 75KB, would require about 225MB of storage. However, many other factors can increase storage needs. OCR text for the same pages might run 3KB per page, or about 1/25th the space required for the corresponding image file. The number and size of derivative files, as well as whether they're permanently stored or created on the fly could add further to storage requirements. In addition, all storage technologies involve a certain amount of wasted space. The precise amount depends on factors such as the storage technology used, total capacity, partition size, and average file size. Some experimentation may be necessary to determine the approximate percentage of wasted space, but it needs to be taken into account in estimating storage needs. The formula above factors in a generous overage to cover such concerns.

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How Many Pages in a Gigabyte?

There are a number of factors that determines how many pages are in a gigabyte. Different document types will generate very different files sizes and take up more space. For example, a Microsoft Word file with just text and no graphics would take up a relatively small amount of file space, but a paper document that has been scanned to a digital, PDF file format image with hidden searchable text can result into a large amount of disk space. The table below summarizes common file sizes based on various document types to help determine how much storage space will be needed when subscribing to Net Documents. (16-17,000 Word Documents = 1GB of storage on average)

Digital Files

DOCUMENT TYPE	AVERAGE SIZE PER PAGE	AVERAGE PAGES PER GIGABYTE
Microsoft Word files	15k	64,800
Microsoft Excel files	6k	166,000
Microsoft PowerPoint files	57k	17,500
Adobe PDF files	100k (image+text)	10,000
Text files	1.5k	677,90
Email files	10k	100,000
Image files (TIFF)	65k	15,477

PDF files are approximately one-tenth the size of a TIFF image, making PDFs much faster to transmit and download. Benefits of PDF over TIFF: 1) Search ability, 2) file size 3) clarity, 4) universal compatibility.

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Scanning Paper Documents

SOURCE	AVERAGE SIZE SCANNED	PER GIGABYTE	# OF PAGES
Scanned Page – TIFF	50k	64,800 pages	1
Banker Box	125MB	8 boxes	2,750
File Cabinet (4 drawer of paper)		2 cabinets	10,000
DVD-ROM (2 sided, 4 layers)	10 GB, 20 Cabinets		

More Information:

A terabyte is a trillion bytes, or a million megabytes, or 1,000 gigabytes, as measured by the hard-drive industry.

A 1-Terabyte drive can hold:

About 330,000 3MB photos

or 250,000 MP3s

or 358 Movies

or 1000 hours of video

An hour of standard video takes up about 1GB, while an hour of high-definition video takes up 4GB.

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Here are a few more details to consider:

- Although data storage capacity is generally expressed in binary code, many hard drive manufacturers (and some newer BIOSs) use a decimal system to express capacity.
  - For example, a 30 gigabyte drive is usually 30,000,000,000 bytes (decimal) not the 32,212,254,720 binary bytes you would expect.
- Another trivial point is that in the metric system the "k" or "kilo" prefix is always lowercase (*i.e.* kilogram = kg *not Kg*) but since these binary uses for data storage capacity are not properly metric, it has become standard to use an uppercase "K" for the binary form.
- When used to describe Data Transfer Rate, bits/bytes are calculated as in the metric system
  - Kilobits per second are usually shortened to kbps or Kbps. Although technically speaking, the term kilobit should have a lowercase initial letter; it has become common to capitalize it in abbreviation (e.g. "56 Kbps" or "56K"). The simple "K" might seem ambiguous but, in the context of data transfer, it can be assumed that the measurement is in bits rather than bytes unless indicated otherwise.

File Storage Capacity by Bits and Bytes				
	bit	**byte**	**Kilobyte**	**Megabyte**	**Gigabyte**
bit	1	8	8,192	8,388,608	8,589,934,592
byte	8	1	1,024	1,048,576	1,073,741,824
Kilobyte	8,192	1,024	1	1,024	1,048,576
Megabyte	8,388,608	1,048,576	1,024	1	1,024
Gigabyte	8,589,934,592	1,073,741,824	1,048,576	1,024	1
Terabyte	8,796,093,022,208	1,099,511,627,776	1,073,741,824	1,048,576	1,024
Petabyte	9,007,199,254,740,992	1,125,899,906,842,624	1,099,511,627,776	1,073,741,824	1,048,576
Exabyte	9,223,372,036,854,775,808	1,152,921,504,606,846,976	1,125,899,906,842,624	1,099,511,627,776	1,073,741,824
Zettabyte	9,444,732,965,739,290,427,392	1,180,591,620,717,411,303,424	1,152,921,504,606,846,976	1,125,899,906,842,624	1,099,511,627,776

File Storage Capacity by Powers of Two (Base 2)										
	bit	**byte**	**Kilobyte**	**Megabyte**	**Gigabyte**	**Terabyte**	**Petabyte**	**Exabyte**	**Zettabyte**	**Yottabyte**
bit	2^0	2^3	2^{13}	2^{23}	2^{33}	2^{43}	2^{53}	2^{63}	2^{73}	2^{83}
byte	2^3	2^0	2^{10}	2^{20}	2^{30}	2^{40}	2^{50}	2^{60}	2^{70}	2^{80}
Kilobyte	2^{13}	2^{10}	2^0	2^{10}	2^{20}	2^{30}	2^{40}	2^{50}	2^{60}	2^{70}
Megabyte	2^{23}	2^{20}	2^{10}	2^0	2^{10}	2^{20}	2^{30}	2^{40}	2^{50}	2^{60}
Gigabyte	2^{33}	2^{30}	2^{20}	2^{10}	2^0	2^{10}	2^{20}	2^{30}	2^{40}	2^{50}
Terabyte	2^{43}	2^{40}	2^{30}	2^{20}	2^{10}	2^0	2^{10}	2^{20}	2^{30}	2^{40}
Petabyte	2^{53}	2^{50}	2^{40}	2^{30}	2^{20}	2^{10}	2^0	2^{10}	2^{20}	2^{30}
Exabyte	2^{63}	2^{60}	2^{50}	2^{40}	2^{30}	2^{20}	2^{10}	2^0	2^{10}	2^{20}
Zettabyte	2^{73}	2^{70}	2^{60}	2^{50}	2^{40}	2^{30}	2^{20}	2^{10}	2^0	2^{10}
Yottabyte	2^{83}	2^{80}	2^{70}	2^{60}	2^{50}	2^{40}	2^{30}	2^{20}	2^{10}	2^0